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Mid-IR imaging of Toomre's Merger Sequence

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Abstract.

We present results on mid-IR (5–16μm) spectral imaging of a sequence of interacting galaxies, observed by ISOCAM. The galaxies are part of the well known Toomre's "merger sequence" which was defined as a sample of galaxies depicting progressive snapshots in the time evolution of a merging event. To trace the intensity of the radiation field in a starburst, we use the ratio of the 15μm to 7μm flux. Our analysis indicates that this ratio increases as galaxies move from the pre-starburst to the starburst phase and goes again down to ~ 1 in the post-starburst phase, a value typical of normal star forming regions in galactic disks. Moreover, we find that the variation of this ratio is well correlated with the one of the IRAS 25μm/12μm and 60μm/100μm flux ratios.

1. Introduction

One of the major steps in the understanding of galaxy evolution was the realization that tails and bridges are the result of galaxy interactions (Toomre & Toomre 1972). The subsequent proposal by Toomre (1977) of using the morphology of the tidal features to create a "merging sequence" of 11 NGC galaxies triggered numerous multi-wavelength studies of those systems (i.e. Hibbard 1995). As a result, several observational characteristics have been tested as alternatives of assigning an "age" to the event of the interaction (i.e. Schweizer 1998). Moreover, the discovery by IRAS of the class of luminous IR galaxies and the revelation later on that they are also interacting/merging systems, attracted further attention to this problem (see Sanders & Mirabel 1996 for a review).

2. Discussion: The Mid-IR perspective

To improve our knowledge of the properties of interacting galaxies in the mid-IR, we used ISOCAM to perform deep spectral imaging observations in the (5–16μm) of sample including most of the well known nearby active/interacting systems (Laurent et al. 1999). The analysis of the spectral characteristics of our sample revealed that in galaxies where an active nucleus does not have a detectable contribution to their mid-IR flux, one can use the flux ratio of LW3(12-18 μm) to LW2(5-8.5 μm) ISOCAM filters as an indicator of the in-

tensity of the star formation activity. This ratio samples the mid-IR continuum emission originating from very small dust grains (radius < 10 nm) heated to high temperatures due to their close proximity to OB stars (Désert et al. 1990).

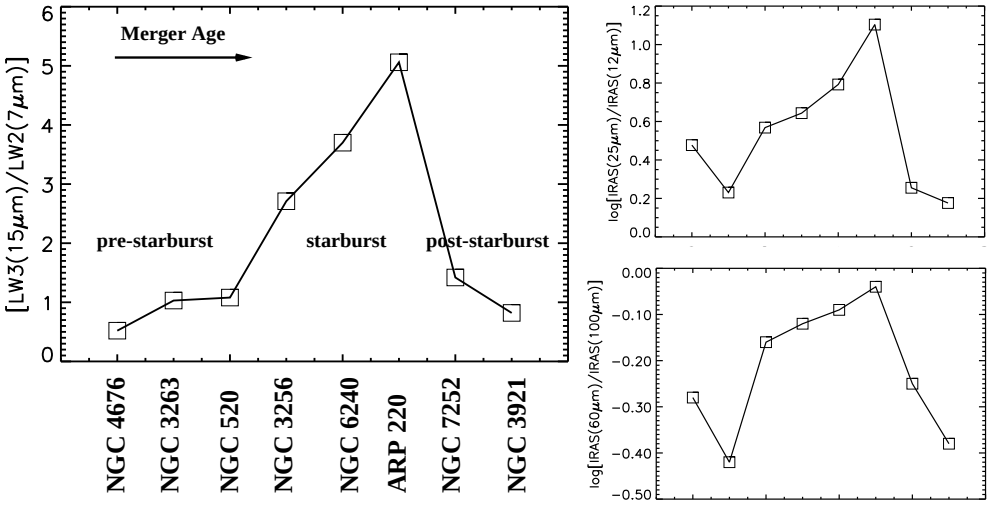

Figure 1. A comparison of the variation of the ISOCAM LW3/LW2 flux ratio along the merging sequence, with the well known IRAS flux ratios. Note how well the ISOCAM starburst diagnostic traces the evolution of the star forming activity/merger age of the sequence. The IRAS $12\mu m$ and $25\mu m$ fluxes, corrected for the extent of the galaxies, have been kindly provided by D.B. Sanders (Univ. Hawaii).

In Fig 1. we present eight galaxies of our sample found in increasing stages of interaction: from NGC 4676, to Arp 220, and NGC 7252. We observe that the ISOCAM LW3/LW2 diagnostic traces the star formation activity in the galaxies and that it is well correlated with the corresponding IRAS flux ratios (Charmandaris et al. 1999). This suggests that even though the bolometric luminosity of luminous infrared galaxies is found at $\lambda \geq 40\mu m$, the study of the mid-IR spectral energy distribution is a powerful tool in understanding their global star formation history.

References

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